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The Provenance of Terrigenous Rocks of the Basal Horizons of the Uralides of the Baidarata Allochthon (Polar Urals) According to the U–Pb Isotope Age of Detrital Zircons

S. N. Sychev[a], A. S. Ivleva[a], S. Yu. Petrov[b], M. N. Petrova[b], V. B. Ershova[a], R. B. Veselovskii[c], and A. G. Konnov[b]

[a]*St. Petersburg State University, St. Petersburg, 199034 Russia*
[b]*Karpinsky Russian Geological Research Institute, St-Petersburg, 199106 Russia*
[c]*Department of Geology, Moscow State University, Moscow, 119991 Russia*

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Abstract—The U–Pb (LA–ICP–MS) age of detrital zircons from the Upper Cambrian–Lower Ordovician terrigenous rocks of the Baidarata Allochthon, which is located in the northern part of the Polar Urals, is determined. The analysis of the youngest zircon population indicates a broad occurrence of the Uralides in this area rather than Pre-Uralides, as was considered previously. The Bedamel island-arc rocks (rather than Timan orogen) were probably the major provenance for the studied sequences. The results of statistical processing of the U–Pb ages of zircons from coeval rocks of Arctic regions suggest similar provenances for the Baidarata Allochthon and Novaya Zemlya and Severnaya Zemlya archipelagoes.

Keywords: Polar Urals, Baidatara Allochthon, Upper Cambrian–Lower Ordovician rocks, detrital rocks, provenance areas

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INTRODUCTION

The analysis of the U–Pb age of detrital zircons is important for deciphering the evolution of the formation of sedimentary basins, first of all, for determining the age of the provenance rocks and transportation paths of detrital material (Gehrels, 2012). The U–Pb ages of detrital zircons from the Upper Cambrian–Lower Ordovician rocks of the basal horizons of the Uralides of the Baidarata Allochthon (Oyuyakha and Talota formations), which were formed during origination of the Uralian Paleoocean (Puchkov, 2012), significantly supplement the ages of similar horizons of the Polar Urals located to the south (Manitanyrd Group and Pogurei Formation) (Soboleva et al., 2012).

REGIONAL GEOLOGY

The studied region is located in the northern part of the Uralian orogen, which has direct contact with the Pai–Khoi fold–thrust system, where the rocks of the Lemva zone (a part of the Baidarata Allochthon) are exposed on the surface (Fig. 1). The Orang Allochthon is located to the northeast of the allochthon, the northern end of which is completely overlapped by Pliocene–Quaternary sediments and is mapped only by scarce drilling data (*Gosudarstvennaya*..., 2015).

The Baidarata Allochthon has a more complex structure and is located beyond the Konstantinov Kamen (the northernmost mountain ridge of the Polar Urals). The allochthon is subdivided into the Western and Eastern nappes, which are separated by the large Osovei Thrust. The Eastern Nappe is composed of the West Osovei and Osovei–Talota sheets, which are separated by the Ngoyuyakha Thrust (*Gosudarstvennaya*..., 2015). All these tectonic units are distinct in a assemblage of composing rocks and structural features. The Western Nappe includes a zone of Devonian–Permian rocks, situated to the west from the valley of the Ngosoveiyakha River. The nappe is composed of siliceous rocks of the Kosvozh (Lower to Middle Devonian), Nyanvorga (Middle Devonian to Lower Carboniferous), and Vargashor (Lower to Upper Carboniferous) formations and flysch of the Upper Carboniferous–Lower Permian Kechpel Formation.

The Eastern Nappe is the largest and most complex element of the Baidarata Allochthon. From the west, it is overthrusted on the Western Nappe along the Osovei Thrust, whereas in the northeast it is overlapped by the rocks of the Orang Allochthon. Structurally, this tectonic block is a large overturned Talota Anticline, which submerges beneath the Ngavyl'yakha Anticline.

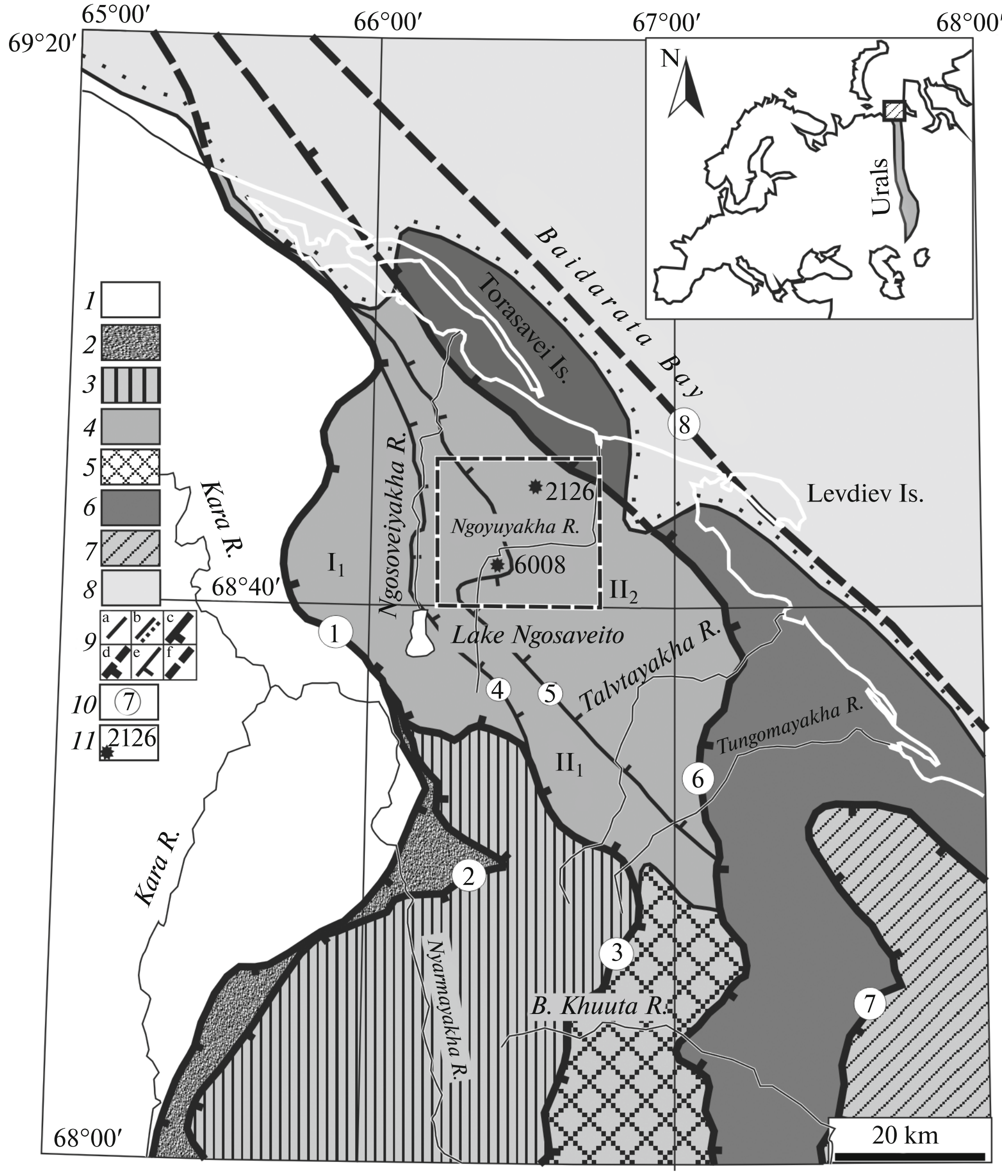

Fig. 1. The tectonic scheme of the northern part of the Polar Urals modified after (*Gosudarstvennaya*..., 2015) (a square marks the location of Fig. 2). *1*, Pai-Khoi fold–thrust system; *2–7*, Urals fold–thrust system: Usa–Verkhnyaya Kara synclinorium: *2*, Kara–Nyarma parautochthon; Polar Uralian anticlinorium: *3*, Ochenyrd parautochthon; Talota–Paipudyn synclinorium: *4*, Baidarata allochthon: I, West Nappe; II, East Nappe (II$_1$, West Osovei Sheet; II$_2$, Osovei–Talota Sheet); *5*, Lekyntalbei Anticline; *6*, Orang Allochthon; Kharbei Anticlinorium: *7*, Nunderma Allochthon; *8*, West Siberian plate; *9*, boundaries of: (a) structures of the second order; (b) of subregional structures; (c) proven major thrusts; (d) inferred major thrusts; (e) subordinate thrusts; (f) inferred major faults; *10*, thrusts and their numbers (in circles): 1, Kara–Nyarma; 2, Khoitalbei–Sebety (Kara); 3, Saureiyakha–Osovei; 4, Osovei; 5, Ngoyuyakha; 6, Orang; 7, Nunderma; 8, Baidarata Fault; *11*, sampling sites and sample numbers.

The West Osovei sheet spans the western wing of the Talota Anticline, which has direct contact with the Osovei Thrust from the east. The anticline core (Syangur block) is composed of the Neoproterozoic–Early Cambrian (Shishkin et al., 2015) Bedamel volcanic rocks, which were considered by Kheraskov (1948) as Pre-Uralides. Due to the longitudinal direction of the Ngosaveiyakha River, almost all geological units (Uralides) of the Baidarata Allochthon are well exposed: the Oyuyakha (Upper Cambrian to Lower Ordovician) and Talota (Lower Ordovician) formations composed of sandstones; the Kharapeshor (Lower to Middle Ordovician) and Salepeyakha (Middle to Upper Ordovician) clayey–shale formations and Kharot (Silurian to Lower Devonian), Kosvozh (Lower to Middle Devonian), Nyan'vorga (Middle Devonian to Lower Carboniferous), and the Vargashor (Lower to Upper Carboniferous) siliceous formations.

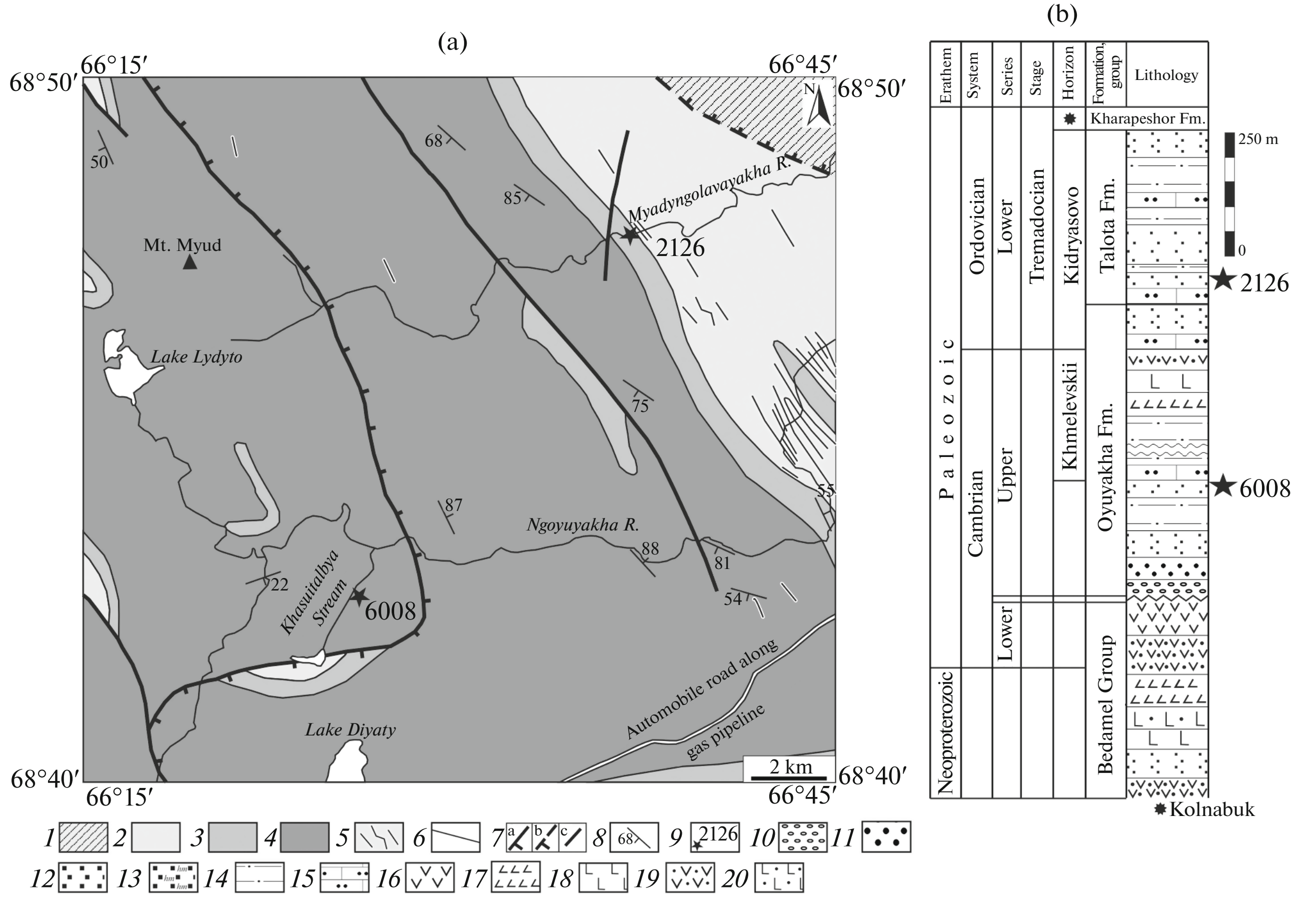

Fig. 2. Schematic geological structure of the middle reaches of the Ngoyuyakha River (northeastern part of the Baidarata Allochthon) (a) and stratigraphic column (b). Composed on the basis of geological map on a scale of 1 : 200 000 (sheets R-42-XXV, XXVI) (Yar area): *1*, Lower to Middle Ordovician Orang Fm.: paraschists of variable sericite–albite–quartz–chlorite composition, siltstones, silty limestones; *2*, Lower to Middle Ordovician Kharapeshor Fm.: silty and clayey limestones, siltstones; *3*, Lower Ordovician Talota Fm.; *4*, Upper Cambrian to Lower Ordovician Oyuyakha Fm.; *5*, Lower to Middle Ordovician Kharapeshor subvolcanic rocks, dikes and sills of dolerites; *6*, proven conformable geological boundaries; *7*, faults: a, proven thrusts; b, inferred thrusts; c, proven faults; *8*, bedding elements of layering; *9*, sampling places and sample numbers; *10*, conglomerates; *11*, gravelites; *12*, sandstones; *13*, hematite-bearing sandstones; *14*, siltstones; *15*, calcareous sandstones; *16*, andesites; *17*, basaltic andesites; *18*, basalts; *19*, andesitic tuffs; *20*, basaltic tuffs.

From the west, the Osovei–Talota sheet is separated from the West Osovei sheet by the Ngoyuyakha Thrust. This sheet includes the Ngavyl'yakha Anticline and the eastern wing of the Talota Anticline and is composed of a complex of formations (except for Vargashor) similar to the West Osovei sheet.

We analyzed the zircons from two sandstone samples collected from the sections of the Oyuyakha (sample no. 6008) and Talota (sample no. 2126) formations in the West Osovei and Osovei–Talota sheets, respectively (Fig. 2). The rocks of the Oyuyakha Formation are mostly lithic and arkose sandstones, conglomerates, and gravelites conformably overlapped by arkose sandstones and siltstones of the Talota Formation. The Late Cambrian age of the rocks of the Oyuyakha Formation is based on acritarch sporadically found by A.S. Miklyaev et al. in the course of geological survey GGS-50. As a result of a later geological survey, its age was indirectly identified as Vendian(?)–Cambrian (Dushin et al., 2004). The Early Ordovician age of the Talota Formation is based on numerous findings of brachiopods and conodonts.

PETROGRAPHY OF SANDSTONES

According to petrographic analysis, the sandstones of the Oyuyakha Formation are lithic and arkose. The lithic sandstones are characterized by inequigranular psammitic and silty psammitic texture with elements of blastic recrystallization and massive layered lens-layered and schistose structure. The detrital material includes (%) angular and/or poorly rounded (with zig–zag boundaries) fragments of quartz (5–10), feldspar (3–7), amphibole (2–5), and biotite (sporadic grains, 1). Variously altered clasts of effusive and volcanosedimentary rocks (mostly, andesites and rare

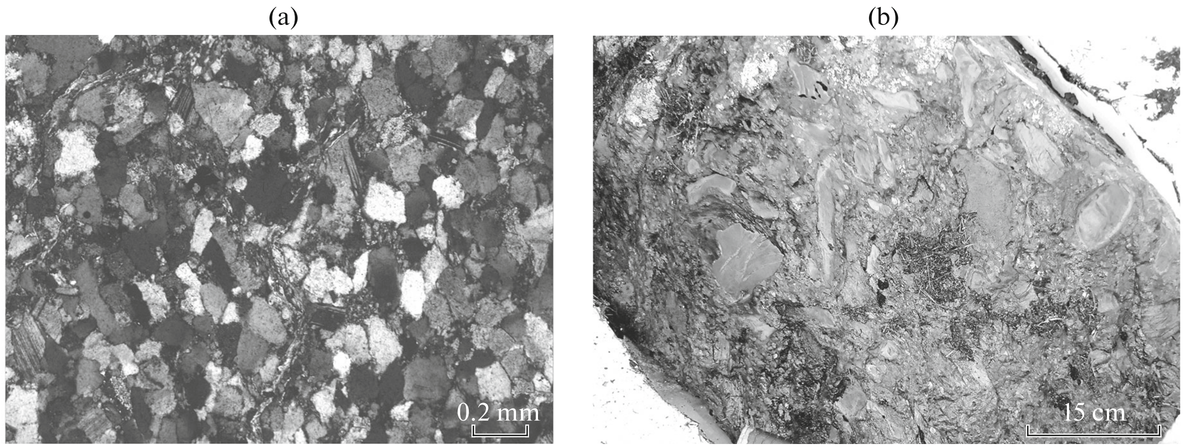

Fig. 3. Micro- and macroimages of the rocks of the formations studied: (a) sandstone of the Talota Fm. (sample no. 2126), with analyzer; (b) conglomerate of the Oyuyakha Fm.

tuffs and clayey shales) comprise ~70–90%. Up to 70% of rock clasts are partly or completely chloritized. Rare grains of tourmaline, leucoxene, apatite, zircon, titanite, muscovite, and orthite are locally observed. The heterogeneous cement consists of hydromicas, actinolite, epidote, chlorite, and, locally, carbonates (≤10%) and organic detritus in the form of small aggregates of carboniferous matter.

The arkose sandstones are characterized by blastopsammitic and rarely blastopsephopsammitic texture and massive or schistose structure. The detrital material (75–95%) of schistose varieties include (65–70%) clasts of quartz (60–80%), plagioclase (20–30%), and rare rock fragments (5%). Pyrite (locally, up to 1–3%), zircon, titanite, and apatite are accessory minerals. The rock clasts are quartzites, felsic and intermediate effusive rocks, and siliceous and sericite–siliceous shales. The moderately sorted poorly rounded, semirounded, and rare rounded clasts are characterized by dominant medium- and coarse-grained psammitic fraction (60–90%) with variable amount of psephitic (0–10%), small-grained psammitic (5–40%), and silty (0–20%) clasts of minerals and rocks. The zircons for isotopic analysis from sample no. 6008 were extracted from poorly sorted arkose sandstone.

The sandstones of the Talota Formation are characterized by psammitic, blastopsammitic, and, to a lesser extent, silty-psammitic texture and massive or schistose structure. The silty constituent is up to 10%. The amount of detrital material varies from 70 to 95%; it is composed of (%) clasts of quartz (75–90), plagioclase (5–15), and rocks (≤10). Zircon, titanite, pyrite, leucoxene, apatite, and tourmaline are accessory minerals. The rock clasts are quartzites, intermediate effusive rocks, and siliceous and sericite–siliceous shales. The moderately sorted clasts are semirounded, poorly rounded, and angular.

It is established as a result of petrographic studies that the sandstones are poorly sorted and poorly rounded and contain high amount of unstable lithic and feldspar grains (Fig. 3a), which indicate the proximal provenance and short distance of transportation of the detrital material. This is supported by the composition of pebbles from conglomerates of the Oyuyakha Formation, which often include variously altered andesites, basaltic andesites, and arkose and subarkose sandstones.

ANALYTICAL METHODS

The samples were preliminarily prepared and detrital zircons were extracted at the Karpinsky Russian Geological Research Institute (VSEGEI, St. Petersburg) following standard methods. The U–Pb age of zircons was determined in VSEGEI on a multicollector high-resolution mass-spectrometer equipped with an excimer ultraviolet New Wave DUV-193 laser (Lambda Physik). The analytical error of each U–Pb analysis is $\pm 2\sigma$. The age of crystallization of zircons of >1000 and <1000 Ma in the primary rock was calculated by $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{238}U$ ratios, respectively. The cumulative probability distribution plots of age values were constructed in the Isoplot 4.0 program. According to (Gehrels, 2012), only grains with discordance of 30% or less were taken into account.

THE U–Pb AGE OF DETRITAL ZIRCONS

In sample no. 6008, the age was determined for 53 detrital zircon grains and only two of them are characterized by discordance of greater than 30% (Table 1). The age varies from ~511 (end of Early Cambrian) to ~1558 (Early Mesoproterozoic) Ma (Fig. 4). The age values exhibit two maximums at 545 and 570 Ma. The zircons with older ages are rare and do not form significant peaks.

In sample no. 2126, 50 grains were analyzed and only 34 grains meet the discordance criterion, the age

Table 1. Results of dating of detrital zircons

Number of analysis	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Age $^{206}Pb/^{238}U$	2σ	Age $^{207}Pb/^{206}Pb$	2σ	Discordance
Sample 6068									
1	0.8044	0.108	0.1005	0.004	617.07	20.46	532.71	3.64	−15.8
2	0.6692	0.034	0.0858	0.002	530.52	11.27	475.31	30.95	−11.6
3	0.8057	0.077	0.0997	0.003	612.50	20.16	553.26	5.69	−10.7
4	0.7750	0.064	0.0964	0.003	593.32	17.26	541.06	4.53	−9.7
5	0.7600	0.060	0.0948	0.003	583.57	18.32	536.31	6.17	−8.8
6	0.7607	0.064	0.0946	0.003	582.97	18.35	540.60	12.31	−7.8
7	0.7348	0.121	0.0919	0.003	566.83	14.89	528.99	7.54	−7.2
8	0.7321	0.045	0.0916	0.003	564.91	14.82	528.67	8.85	−6.9
9	0.8085	0.096	0.0991	0.003	609.02	16.37	573.91	23.65	−6.1
10	0.7630	0.064	0.0944	0.003	581.35	17.76	553.74	6.57	−5.0
11	0.7161	0.036	0.0896	0.002	552.96	14.29	529.20	4.91	−4.5
12	0.7020	0.028	0.0881	0.003	544.23	15.04	522.07	10.52	−4.2
13	0.7174	0.042	0.0895	0.002	552.80	13.15	533.80	9.23	−3.6
14	0.7547	0.024	0.0932	0.003	574.64	16.79	556.14	11.55	−3.3
15	0.7394	0.058	0.0917	0.003	565.50	15.77	548.19	6.43	−3.2
16	0.8152	0.077	0.0990	0.003	608.75	20.27	592.60	7.64	−2.7
17	3.2600	0.114	0.2595	0.006	1487.50	31.97	1448.64	17.90	−2.7
18	0.7041	0.050	0.0880	0.002	543.70	13.84	531.00	62.38	−2.4
19	0.7424	0.051	0.0918	0.002	566.02	12.32	554.83	19.24	−2.0
20	0.7015	0.028	0.0876	0.002	541.27	13.35	533.00	10.13	−1.6
21	0.7065	0.023	0.0880	0.003	543.88	15.02	537.65	8.44	−1.2
22	0.6710	0.038	0.0844	0.002	522.31	13.32	517.10	25.25	−1.0
23	0.7049	0.029	0.0878	0.002	542.32	14.17	539.32	5.68	−0.6
24	0.7143	0.043	0.0886	0.002	547.08	13.27	548.16	7.27	0.2
25	0.6957	0.033	0.0867	0.002	535.89	13.04	537.66	6.23	0.3
26	0.6828	0.034	0.0851	0.002	526.69	12.68	536.13	18.57	1.8
27	0.6981	0.031	0.0867	0.002	535.75	13.07	545.77	25.09	1.8
28	0.7653	0.031	0.0932	0.003	574.35	17.40	587.84	20.79	2.3
29	0.7245	0.031	0.0891	0.003	549.92	15.67	567.37	5.91	3.1
30	0.7603	0.042	0.0925	0.003	570.29	14.86	589.63	13.82	3.3
31	0.6871	0.034	0.0853	0.002	527.54	14.15	546.14	14.35	3.4
32	0.6907	0.036	0.0856	0.002	529.66	12.20	548.66	28.90	3.5
33	3.4981	0.190	0.2627	0.006	1503.70	30.63	1558.95	11.35	3.5
34	0.6927	0.029	0.0857	0.002	530.00	14.25	553.29	18.91	4.2
35	0.6970	0.024	0.0861	0.002	532.62	11.99	555.77	11.69	4.2
36	0.7071	0.056	0.0871	0.002	538.39	13.57	562.35	20.16	4.3
37	0.6708	0.023	0.0833	0.002	515.76	11.59	544.97	17.16	5.4
38	0.7337	0.069	0.0894	0.002	551.81	12.17	587.04	32.97	6.0
39	0.6715	0.028	0.0831	0.002	514.81	11.01	551.55	41.20	6.7
40	0.6816	0.040	0.0840	0.002	519.96	13.91	561.42	22.80	7.4
41	0.7514	0.032	0.0907	0.003	559.83	18.98	606.08	29.92	7.6
42	0.9132	0.094	0.1047	0.004	642.12	21.08	716.13	12.08	10.3
43	0.7455	0.048	0.0890	0.002	549.57	12.11	630.66	39.10	12.9

Table 1. (Contd.)

Number of analysis	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Age $^{206}Pb/^{238}U$	2σ	Age $^{207}Pb/^{206}Pb$	2σ	Discordance
44	0.6831	0.029	0.0828	0.002	513.01	11.73	596.89	35.19	14.1
45	0.7030	0.038	0.0845	0.002	522.65	11.35	616.84	46.94	15.3
46	0.6838	0.030	0.0825	0.002	511.14	11.64	607.25	35.92	15.8
47	0.8152	0.122	0.0944	0.003	581.73	17.20	694.80	8.4	16.3
48	0.6918	0.029	0.0826	0.002	511.74	10.91	629.60	29.55	18.7
49	0.8319	0.078	0.0951	0.003	585.44	16.81	723.77	37.02	19.1
50	0.9706	0.044	0.1064	0.002	651.73	14.51	811.65	57.39	19.7
51	0.8411	0.057	0.0952	0.002	586.32	13.74	743.79	37.28	21.2

of which varies from ~515 (end of Early Cambrian) to 1667 (Late Paleoproterozoic) Ma (Table 2). The age values of zircons (31 grains or 91%) range from the end of the Early Cambrian (~515 Ma) to the end of the Neoproterozoic (~650 Ma) and form one expressive peak of ~522 Ma (Fig. 4). Other zircons with ages of ~1168, ~1632, and ~1667 Ma are rare.

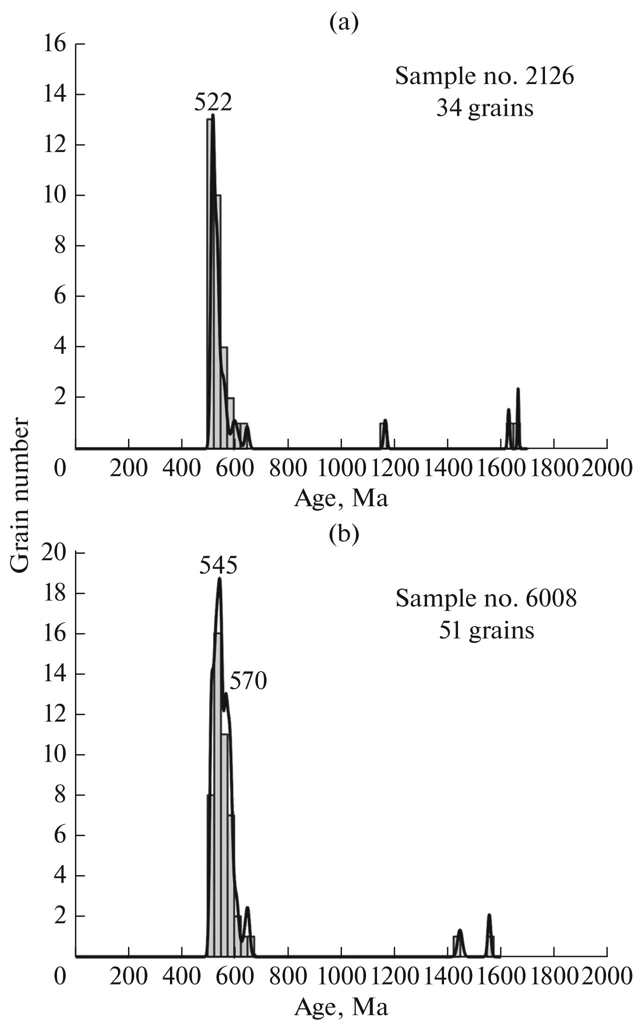

Fig. 4. Histograms and cumulative probability distribution plots of U–Pb age values of detrital zircons from sandstones of Talota (a) and Oyuyakha (b) formations.

DISCUSSION

Our data allow us to refine the age of the Oyuyakha Formation and, on the basis of the youngest group of detrital zircons, to accept it as no older than Middle Cambrian. It is noteworthy that in the West Uralian megazone of the Polar Urals no Middle Cambrian sedimentary rocks are known. Taking the position of the Oyuyakha Formation in the section directly below the sandstones of the Talota Formation into account and due to the findings of the Tremadocian brachiopods in both formations (Shishkin et al., 2015), the age of the Oyuyakha Formation can be considered as Late Cambrian–Early Ordovician.

The ages of these zircons are similarly distributed suggesting a dominant role of the same provenances of detrital material. As an example, our samples contain mostly Late Neoproterozoic–Early Cambrian grains (94%). The coeval tectonomagmatic events occurred along the northeastern (in modern coordinates) margin of the Baltic, which was a marginal volcanoplutonic belt of the Andean type (Pechora island-arc system) in the Neoproterozoic–Early Cambrian (Samygin and Burtman, 2009; Kheraskova et al., 2010). In the Polar Urals, active basaltic andesite and andesite volcanism started at the middle of the Neoproterozoic, as well as the accumulation of thick tuffaceous–sedimentary rocks of the Ochetyvis complex, which is ascribed to the lower part of the Bedamel Group. From the end of the Neoproterozoic, dacites and rhyolites, as well as gabbroic rocks, diorites, and granodiorites of the Kyzygei complex, have been formed in the structure of the Lyadgei volcanic complex (the upper part of the Bedamel Group) along with andesites.

Collision processes resulted in fold deformations and the Timan orogenesis began in the Late Neoproterozoic–Early Cambrian. The orogenic processes led to accumulation of volcanomictic molasses of the

Table 2. Results of dating of detrital zircons

Number of analysis	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Age $^{206}Pb/^{238}U$	2σ	Age $^{207}Pb/^{206}Pb$	2σ	Discordance
Sample 2126									
1	0.7752	0.244	0.0996	0.003	612.21	20.39	469.56	281.72	–30.0
2	0.7240	0.212	0.0933	0.003	575.12	19.68	463.19	277.80	–24.2
3	0.7806	0.450	0.0975	0.003	599.58	16.36	532.89	200.23	–12.5
4	0.8735	0.039	0.1061	0.002	649.90	14.27	593.50	39.35	–9.5
5	0.6897	0.033	0.0870	0.002	538.00	14.60	509.52	21.43	–5.6
6	2.2239	0.106	0.2045	0.006	1199.52	32.33	1168.76	10.98	–2.6
7	4.2847	0.225	0.3035	0.008	1708.68	40.84	1667.86	5.27	–2.4
8	0.7320	0.031	0.0907	0.002	559.70	14.57	549.72	27.47	–1.8
9	0.6923	0.022	0.0867	0.003	535.95	15.04	526.69	14.42	–1.8
10	0.6729	0.028	0.0845	0.002	523.06	14.45	519.94	21.38	–0.6
11	3.8962	0.195	0.2813	0.008	1598.01	38.64	1632.38	8.03	2.1
12	0.6724	0.028	0.0840	0.002	520.04	12.66	531.55	23.75	2.2
13	0.7054	0.061	0.0873	0.003	539.60	16.68	552.26	22.93	2.3
14	0.7004	0.039	0.0867	0.002	536.14	11.85	551.16	26.93	2.7
15	0.6787	0.037	0.0844	0.002	522.62	11.44	540.77	31.77	3.4
16	0.6789	0.034	0.0842	0.002	521.07	11.62	547.96	29.99	4.9
17	0.6777	0.032	0.0841	0.002	520.35	11.56	547.28	30.97	4.9
18	0.7332	0.040	0.0894	0.003	552.19	17.58	584.07	12.28	5.5
19	0.6866	0.043	0.0847	0.002	524.30	13.87	558.64	21.78	6.1
20	0.6786	0.033	0.0838	0.002	518.90	11.35	556.45	43.75	6.7
21	0.6801	0.035	0.0837	0.002	518.24	11.85	564.22	36.21	8.1
22	0.6912	0.033	0.0848	0.002	524.72	13.41	571.29	32.97	8.2
23	0.7109	0.034	0.0867	0.002	535.79	13.83	585.27	20.83	8.5
24	0.6881	0.033	0.0844	0.002	522.54	13.18	570.96	41.67	8.5
25	0.6876	0.037	0.0839	0.002	519.27	12.47	583.67	40.72	11.0
26	0.6837	0.033	0.0834	0.002	516.25	11.97	584.50	21.40	11.7
27	0.6817	0.031	0.0832	0.002	514.95	11.58	583.70	27.79	11.8
28	0.7748	0.045	0.0920	0.002	567.12	13.76	643.11	20.49	11.8
29	0.7302	0.066	0.0877	0.002	541.64	12.28	618.52	25.53	12.4
30	0.7320	0.040	0.0876	0.003	541.10	16.41	626.08	13.00	13.6
31	0.7331	0.042	0.0867	0.002	536.19	14.37	649.95	26.97	17.5
32	0.7743	0.156	0.0900	0.003	555.34	15.11	688.47	143.72	19.3
33	0.7261	0.037	0.0853	0.002	527.65	12.45	665.17	15.16	20.7
34	0.7679	0.061	0.0861	0.002	532.70	14.02	762.92	43.33	30.0

Arkanyrd Formation (Lower Cambrian). Probably, abundant proximal Neoproterozoic–Early Cambrian island-arc complexes of the Bedamel Group, as well as Kyzygei intrusion, were the main provenances for the studied formation (Sychev and Ivleva, 2015).

Poor correlation is observed between cumulative isotope age curves of the detrital zircons and the data on zircons, which were extracted from coeval rocks located southward in the carbonate Elets (Manitanyrd Group) and schist Lemva (Pogurei Formation) zones of the Polar Urals (Soboleva et al., 2012) (Fig. 5). The samples from the southern part of the Polar Urals contain both Late Neoproterozoic–Cambrian and numerous Paleo- and Mesoproterozoic zircons (Soboleva et al., 2012); the latter are extremely rare in our samples. The igneous rocks related to the origination of the Timan orogen in the Late Neoproterozoic–Early Cambrian (Ivleva et al., 2016) and older com-

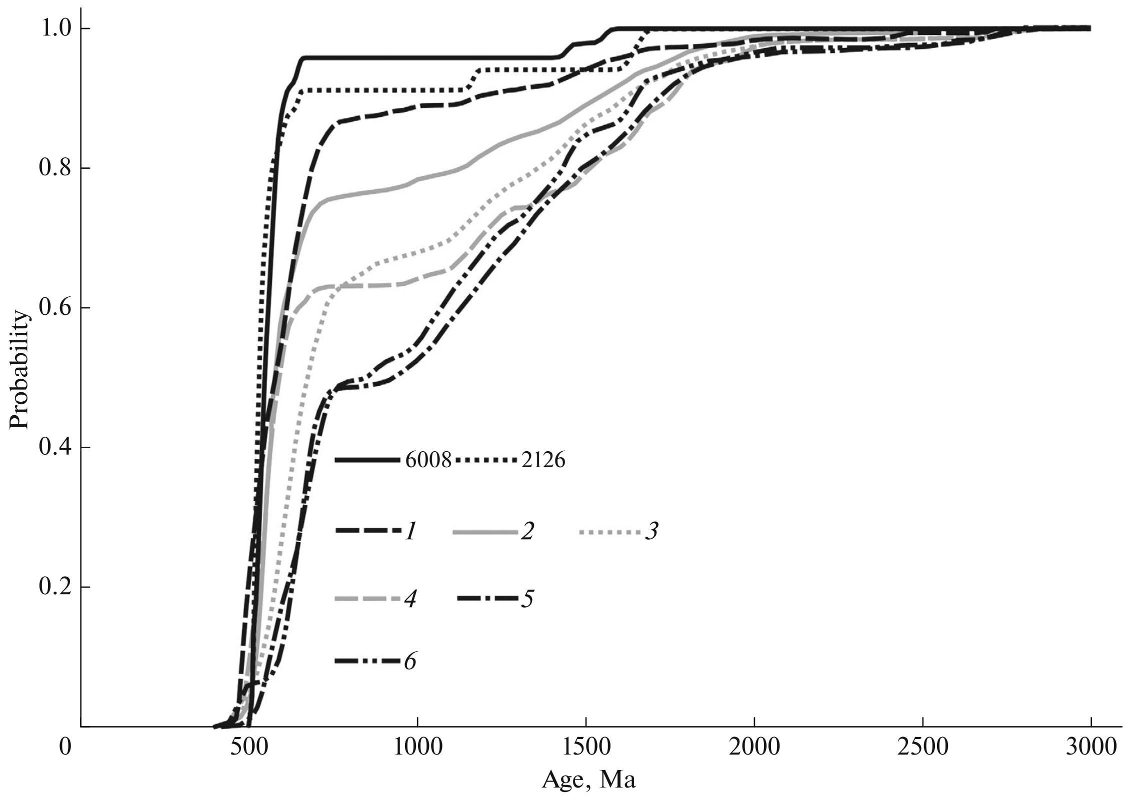

Fig. 5. Comparison of cumulative curves of the isotope age of detrital zircons from the rocks of the Oyuyakha (6008) and Talota (2126) formations with those from Cambrian–Ordovician rocks of Novaya Zemlya (*1*) (Pease and Scott, 2009; Lorents et al., 2013), Cambrian–Ordovician rocks of Severnaya Zemlya (*2*) (Lorents et al., 2008; Ershova et al., 2015), Upper Riphean–Cambrian rocks of the Western Africa (*3*) (Amato et al., 2009), Upper Cambrian–Early Ordovician rocks of the southern part of the Polar Urals (Manytanyrd Group and Pogurei Formation) (*4*) (Sobolev et al., 2012), Upper Cambrian–Early Ordovician rocks of De Long Archipelago (Henrietta and Jeannette islands) (*5*) (Ershova et al., in press), and Cambrian–Ordovician rocks of the North American Cordillera (Alexander Terrane) (*6*) (Beranek et al., 2013).

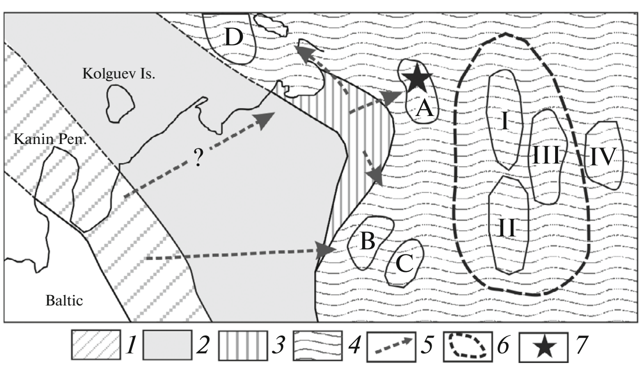

Fig. 6. The paleogeographic scheme of the Timan margin of Baltic (conditionally remained immobile) for the Late Cambrian–Early Ordovician with possible transportation pathways of detrital material: (*1*) Timan orogen; (*2*) Pechora plate; (*3*) Bedamel island-arc rocks; (*4*) passive margin; (*5*) inferred transportation pathways of detrital material; (*6*) terranes and microcontinents in structure of Arctida (Zonenshain et al., 1987); (*7*) studied region. Letters, areas of rock accumulation: A, Oyuyakha and Talota formations; B, Manitanyrd Group; C, Pogurei Formation; D, coeval rocks of Novaya Zemlya. Roman numerals: I, Severnaya Zemlya Archipelago; II, Western Alaska; III, De Long Archipelago; IV, Alexander Terrane.

plexes (Fig. 6) were the provenances for the Upper Cambrian–Lower Ordovician rocks of the Manitanyrd Group and Pogurei Formation, whereas for our zircons the major provenance is related to the Bedamel island-arc complexes.

The comparison of the age distribution of the detrital zircons from the coeval rocks of the Arctic revealed some patterns (Fig. 5). As an example, the age distribution of detrital zircons from terrigenous rocks of the Baidarata Allochthon and Novaya Zemlya and Severnaya Zemlya is rather similar. At the same time, the age distribution of detrital zircons from the southern parts of the Lemva zone showed similar data for coeval rocks of the West Alaska, Novosibirsk Islands (De Long Archipelago), and the North American Cordillera (Alexander Terrane). This allows us to specify reconstructions for the Cambrian–Ordovician (Miller et al., 2011; Beranek et al., 2013; Ershova et al., in press) and to find a place for spatially isolated terranes along the Timan margin of Baltic in paleointerpretations.

CONCLUSIONS

As a result of our studies, the age of the rocks of the Oyuyakha Formation was refined (Late Cambrian to Lower Ordovician). It was shown that the basal horizons of the Uralides of the Polar Urals are characterized by various provenances of detrital material, which was transported from the Timan orogen in the south and from island-arc Bedamel Group in the north. The results of statistical processing of the U–Pb ages of zircons from coeval rocks of Arctic regions indicate similar provenance for the Baidarata Allochthon and Novaya Zemlya and Severnaya Zemlya archipelagoes.

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